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A survey of the basic arithmetic skills in grades six seven and eight of the Missoula public schools 1951-1952

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A SURVEY OF THE BASIC ARITHMETIC SKILLS

IN GRADES SIX SEVEN AND EIGHT

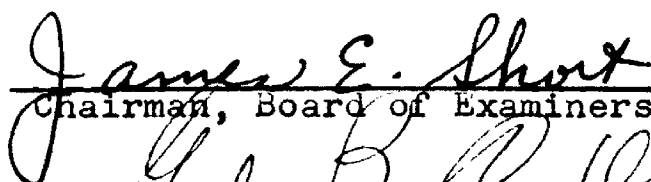OF THE MISSOULA PUBLIC SCHOOLS

1951 - 1952

by

EDWIN GREMMER

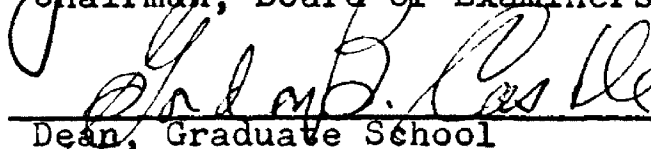B. A. Montana University, 1951

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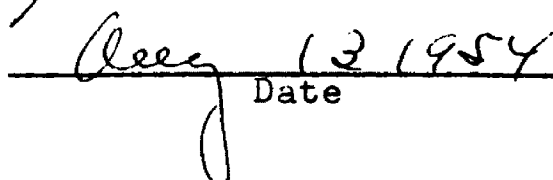
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CHAPTER I

INTRODUCTION

Effectiveness of instruction in any field of education is of some concern to most personnel involved in the education of boys and girls. This study is an attempt to discover useful information pertaining to the proficiency of students in their use of some of the basic arithmetic skills. Data and results are confined to the performance of the sixth, seventh and eighth grade students of the Missoula Public Schools on an arithmetic diagnostic test[1].

The problem of this paper divides itself into two distinct and separate parts. First, an instrument had to be found that could be used to measure the proficiency of the Missoula grade school students. This was accomplished by analyzing the items of this standardized diagnostic test and grouping the items into skills that they seemed to test. Secondly, it was important to discover the relative proficiency that the children of the three upper grades in the Missoula Public Schools have in the skills that instrument attempts to measure. This is the main part of the paper and is expressed in Chapter IV.

Effort was made to find other diagnostic studies that could be used to compare the results of this study;

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[1] *Iowa Every Pupil Tests of Basic Skills*, Houghton Mifflin Co., Boston, Mass., 1943.

however, none was available, and it was therefore impossible to compare the performance of the students of the Missoula schools with any other diagnostic measure of this type. An attempt was made to compare the results of any one of the skills with the results found in the other skills that were tested. The comparison included in Chapter IV, was developed by plotting the mean percentage of all skills tested.

The reader will find this study to be a detailed report on the actual performance of 279 sixth-grade children, 302 seventh-grade children, and 186 eighth graders. The number indicated is not the actual number of children in each of the grades mentioned because the test results from one of the Missoula's Public Schools were inadvertently destroyed prior to any mention made of their being used in a research study. In grade eight, three schools are not represented for the same reason.

The diagnostic test was administered during the first week of October of 1951. At this early date in the school year, the teachers had had some time to review a portion of the previous year's work. Little if any time had been available for the teaching of new materials at this point in the school year.

The desire of most teachers is to teach each child as much as possible; however, before much teaching can be accomplished it is necessary that the teacher know the extent of the ability of each student. The teacher should know how

proficient the child is in each of the skills before extending further teaching in the field of arithmetic. This of course is true, also, of the other fields of educational endeavor. In order to strengthen and improve the skills of arithmetic it is necessary to build up the weaker skills, thereby improving the whole structure. A division of skills will be noted in Chapter II.

Some conclusions that were apparent are discussed in Chapter V. Too, there are to be found some recommendations for applying the results of the study in such a way that improvement of the skills might be realized.

CHAPTER II

THE TEST AND RELATED FORMS

In many cases the testing program in a school system is determined by a policy previously established. In this case however, there had never been a series of diagnostic tests given system-wide. This fact brought up the problem of choosing a battery of tests that seemed to meet the needs most adequately.

After much examination and deliberation by the administrative staff, the battery of tests known as the Iowa Every Pupil Tests of Basic Skills[2] was accepted.

The test given in arithmetic is known specifically as Test D: Basic Arithmetic Skills -- Form Q, Advanced Battery[3] for grades 5, 6, 7, 8 and 9.

"Part I, Vocabulary and Fundamental Knowledge," is made up of 40 different items.

"Part II," is divided into two sections: "Section A," "Whole Number and Fractions," items 41 through 63; and "Section B," "Percentage and Decimals," items 64 through 73.

"Part III, Problems" consists of items 74 through 104.

"Part III" was not analyzed in this study because of the nature of the items. All the items of this part are written problems and before a pupil could attempt the

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[2] Iowa Every Pupil Tests of Basic Skills, Houghton Mifflin Co., Boston, Mass., 1943.

[3] Ibid.

-4-

computation of any one item it was first necessary that he be able to read accurately.

Morton[4] once wrote:

> Nor is it surprising that the ability to read paragraphs understandingly counts heavily in solving arithmetic problems. Before the pupil can begin to devise a solution for a problem, he must know what the conditions of the problem are and he must understand clearly what is required. Ordinarily he gets this information from reading a printed or written statement of the problem as given in a textbook or elsewhere. Skillful reading precedes the pupil's efforts to think out the steps of the solution. Accurate computation follows and permits him to put his thinking into full effect.

In October of 1951 the tests were administered in all the Missoula Public Schools. The principal of each building was directed to give the tests. The teachers then corrected each answer sheet and tabulated the results according to the directions supplied by the test publishing company.

Upon close examination of the results, as they were found and tabulated according to the publisher's directions, a great deal of specific information was not available. The information that was forth-coming was recorded in four large areas which were: 1, "Fundamental Knowledge;" 2, "Fundamental Operations;" 3, "Problems;" and 4, "Total Score." This information, recorded in such broad areas, was not well enough refined to be of much value in determining the proficiency of children in the upper three grades as far as specific skills were concerned.

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[4] Robert L. Morton, Teaching Arithmetic in the Elementary School. (New York: Silver Burdett Co., 1938) p. 31.

In order for the teacher to improve the arithmetic skills she should have information pertaining to the actual performance the children made in using these skills. This detailed information was not made available by the results as recorded by the teachers.

The kinds of information that were needed to increase the effectiveness of teaching were: 1, an analysis of the specific skills; 2, the degree of error and the degree of accuracy in each skill; 3, the overall picture of the performance shown by the children of the entire system; and 4, the design that might be used to improve the skills that appeared weak.

The data were collected from each of the schools. Immediately it became evident that the scope of tabulating results of this one diagnostic test was far too great a task for one person to arrange in terms of an item analysis. A letter[5] was written requesting teachers and pupils to lend assistance in compilation of the data necessary to complete the analysis. Included with this letter were a key sheet[6] of answers and a set of instructions as to how the teacher and the pupils could go about the task of obtaining the data required. A tally sheet[7] designed specifically for the tabulation of the results made it possible for the teacher to record the number of attempts, the number of right

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[5] See Appendix A.

[6] See Appendix B.

[7] See Appendix C.

responses, the number of wrong responses, and the number of omissions for each item tested.

The teachers and the pupils readily accepted the task and within a week had tabulated and returned the tally sheet for their grade.

The diagnostic test results were examined after having been tallied by teachers and pupils, and items were coupled with applicable skills.

The test publishing company had suggested, in their "Examiner's Manual,"[8] a "break down" of the 40 items found in "Part I" into eight specific arithmetic skills. This suggestion was accepted as valid and was used in the grouping of the items for this portion of the test.

"Part II" of the test, which has 33 items, was separated into fourteen skills arbitrarily. A letter was written to the testing company asking them to supply a "break down" of the items tested in "Part II." They explained that they had no such analysis but did suggest that the items found in this part of the test be grouped as they best followed the local course of study in arithmetic.

Even though there appeared to be overlapping skills involved in some of the items, no effort was made to analyze any of the interdependent skills. For example, problems of division were considered wholly as division skills. No attempt was made to consider the addition, subtraction,

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[8] "Examiner's Manual," Iowa Every Pupil Tests of Basic Skills, Houghton Mifflin Co., Boston, Mass., 1943.

and the multiplication skills which would be necessary to accomplish successfully items involving division. Similarly, skills involved in accurately accomplishing other problems have not been analyzed in this study.

A study of this nature becomes involved in the use of a great many numbers which must be kept easily identified in order to avoid unnecessary errors in tabulating the data. To facilitate the handling of these numbers, three forms were designed. The form used by the teacher was called the "Tally Sheet." On the tally sheet the teacher recorded the number of attempts, the number of right responses, the number of wrong responses, and the number of omits for each item of the test.

As the tally sheets came in from each of the schools, the results found on each sheet were placed on another sheet known as the "Analysis Sheet Per Skill and Item."[9] Totals for the entire school system were found for each item. From these totals the per cent of attempts right, the per cent of attempts wrong, and the per cent of items omitted were computed. These totals were then recorded on a third form called the "Computation Sheet of Items and Their Respective Skills."[10] A composite picture of each skill in each of the three grades tested was determined by totalling the results and computing the percentages for each item as it was

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[9] See Appendix D.

[10] See Appendix E.

listed on the "Computation Sheet of Items and Their Respective Skills." This information appears at the beginning of the discussion of each of the skills as they appear in Chapter IV.

The schools listed are the eleven Missoula Public Elementary Schools. They are not named because this study was not intended to compare any one Missoula school with another; rather it was a study to evaluate the proficiency of the pupils of the entire Missoula Grade System.

CHAPTER III

REVIEW OF RELATED LITERATURE

Probably no one subject in the elementary school curriculum has been written about more than the area of arithmetic. Studies and findings have been forthcoming from the experts and authorities for many years. Much of the literature reviewed, however, is not directly related to the problem of diagnosis of pupils' errors. It does not seem justifiable here to relate all the studies made in the field of pupils' arithmetic errors. Some review will be given of a few prominent studies in the area of diagnostic testing.

Buswell and John[11] in 1926 made a very detailed examination of the errors made in the four fundamental processes of computation. They went so far as to determine the cause of errors in each basic skill for each process of addition, subtraction, division and multiplication. This study also presents some information pertaining to the eye-movements in the process of adding a column of figures.

Dr. Robert L. Morton[12] has written numerous volumes in the field of arithmetic. One of his works that is pertinent to this paper is his "Analysis of Pupil's Errors in

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[11] G.T. Buswell and Lenore John. Diagnostic Studies in Arithmetic. Chicago, Illinois, University of Chicago, 1928.

[12] Robert L. Morton. "Analysis of Pupil's Errors in Fractions," Journal of Educational Research. Vol. 9, No. 2, Feb. 1924.

Fractions." His study, which was done in October of 1924, was based on a series of tests to eighth grade students at the University Training School of Athens, Ohio. The tests were of a diagnostic nature designed to discover some facts about the pupil's ability to do the four fundamental operations in fractions.

The tests included 2,174 examples. They were given in November and April. In the November test which was given to 36 pupils, 663 examples were found wrong. In April, 35 of the same pupils tried 2,035 examples. In this test, 366 were found wrong.

The two testing periods included 4,209 examples of which 1,029 were wrong. The author found the children to be 76 per cent accurate in the two tests. In the addition portion of the test, there were 268 wrong in November and 82 wrong in April.

For the subtraction he found 112 errors for 36 pupils in November and 77 errors for 35 pupils in April.

Errors in multiplication for 36 pupils in November were 130; 86 wrong for the 35 students in April. The 36 pupils made 157 errors in November and in April, 35 pupils made 141 errors.

Morton stated that in 91.3 per cent of the cases, it was possible to detect the causes of the errors of the eighth grade pupils who took the tests in the four fundamental operations of fractions. Most of the errors he ascribed to three causes:

1. Inadequate conception of the processes involved.

2. Confusion of the operations.

3. Lack of an adequate degree of skill in fundamental operations with integers.

The information collected from the experiments seem to indicate that a satisfactory degree of skill may be produced in pupils through a detailed analysis of their faults and through systematic drills in the form of practice exercises.

How much arithmetic does daily life require? This question was answered by Wilson[13] and others through surveys of adult usage. The results indicate, first, that the typical adult is constantly faced with practical problems involving arithmetic computation and reasoning; second, that the requirements on the reasoning and thinking side are usually greater than on the computation side; and, third, that even the most complicated reasoning required is scarcely beyond the average mentality of a twelve-year old child.

Wilson and Dalrymple[14] analyzed adult needs for fractions and found that fractions with small denominators predominate; but few problems with unlike denominators, eighths and twelfths, or even fourths and halves, are met. They

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[13] G.M. Wilson, Survey of the Social and Business Usage of Arithmetic. Teachers College Contributions to Education, No. 100. New York; Bureau of Publications. Columbia University Press.

[14] G.M. Wilson and C.O. Dalrymple, "Useful Fractions," Journal of Educational Research, XXX, 1937.

stated that 90 per cent of adult needs in arithmetic are satisfied by the four fundamental processes as they apply to whole numbers and a few fractions. Decimals, except in United States money, do not occur in ordinary day to day experiences. Adults need only a reading knowledge of decimals.

An outstanding piece of professional work was done by Washburne[15] and others in 1939. This was their report of the "Committee of Seven" in which they offered suggestions for the grade placement of arithmetic materials based on mental maturity of children and difficulty of the material. As a result of this study there has been a marked change in the design of recent arithmetic textbooks.

The study of Knight and Behrens[16] indicates that some combinations are more difficult than others, and that in order to teach them more effectively, teachers must know how much practice is needed for the mastery of each combination. Correct teaching, with drill properly distributed and correct emphasis given to specific tasks, will prevent many of the present failures in arithmetic.

Many leading authorities in the field of arithmetic have discovered the most frequent sources of error are in the four fundamental processes of arithmetic. In a study,

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[15] Carleton Washburne, "The Grade Placement in Arithmetic Topics," National Society for the Study of Education, 38th Yearbook, 1939.

[16] F.B. Knight and M.S. Behrens, The Learning of the Hundred Addition Combinations and the Hundred Subtraction Combinations. New York; Longmans, Green and Co. Inc. 1928.

Brueckner[17] listed the common sources of errors to be:

1. Performing wrong operations or mistaking the sign.

2. Failure to complete work.

3. Guess work and carelessness.

4. Careless writing of numbers.

5. Indirect solution and use of "crutches."

6. Failure to handle zeros properly in all operations.

7. Counting in computation.

Many errors are due to the formation of wasteful and harmful habits, and the neglect of useful and necessary skills. According to Thorndike[18] there is a "loss of learning by the dying out of bonds for lack of exercise, from failure to repeat them frequently after their first learning, and the efficacy of early repetitions over older ones."

Hildreth[19] discusses mental ability as a factor of note in determining the pupil's ability to do arithmetic. She relates that the mentally deficient child almost invariably has difficulty with arithmetic. Not all children who are slow in arithmetic are mentally backward, but the typical mentally subnormal child cannot learn arithmetic in the sense of using computation successfully in the solution of problems through the usual methods of teaching.

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[17] L.J. Brueckner, Diagnostic and Remedial Teaching in Arithmetic. Philadelphia: The John C. Winston Co., 1930.

[18] E.L. Thorndike, New Methods in Arithmetic. Chicago: Rand McNalley and Co., 1921. p. 286.

[19] Gertrude Hildreth, Learning The Three R'S. Minneapolis: Educational Publishers Inc., 1947. p. 844.

Teachers who are interested in a current publication that may be of considerable aid to their instruction in the classroom should add to their professional library Robert L. Morton's[20] "Teaching Children Arithmetic." This is a volume of current practices and techniques that have been found effective in the teaching of arithmetic throughout the eight elementary grades.

Another valuable publication which should be on hand in each school building is the quarterly publication of "The Arithmetic Teacher."[21] This magazine provides information that is current in the field of arithmetic.

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[20] Robert L. Morton, Teaching Children Arithmetic. (New York: Silver Burdett Co.), 1953.

[21] The Arithmetic Teacher, Quarterly, The National Council of Teachers of Mathematics, State University Teachers College, Cortland, New York.

CHAPTER IV

REVIEW OF THE TWENTY-TWO SKILLS

The Iowa Every Pupil Tests were given on October 5, 1951, which was about one month after school had begun. The children of grades six, seven and eight, at this point in the school year, had no time for experiencing new arithmetic materials other than to review a portion of their previous year's work. Actually, then, each grade cannot be held responsible for materials that are usually introduced into their courses of arithmetic study after one month of school.

In answering each of the items, the children had a choice of four answers plus the possibility of omitting the item entirely. The pupils also were under some pressure because of the time element. Fifteen minutes were allowed for Part I. After nine minutes, the pupils were told to go on to page two; then, they were given six minutes to complete page two.

Part II was divided into Sections A and B. Seventeen minutes were allowed for Section A, eight minutes for Section B. Four minutes after Section B of the test had been started, the children were reminded that their time was half gone.

The information that follows in this chapter is divided into twenty-two parts, following a pattern somewhat like a handbook to which a teacher may turn to find specific

information pertaining to the performance the children of grades six, seven and eight had shown on the diagnostic test.

Each skill has a table which includes the results each grade made on each of the items which were grouped together to make up each of the skills. The table for each skill is placed at the top of the page for ease in locating information pertinent to the skill. Following the tables involving the results of each skill, are reproduced the items from the test which measure that skill. The discussion for each of the skills is confined mainly with the per cent of items right. Some comparison is made of the per cent of items right in the cumulative data for each skill with the average performance each grade made in the twenty-two skills. Where other factors such as per cent of omissions and regressions occur, mention is made.

A figure showing the per cent of items right and the mean score for each grade is included in this chapter. Grade six had a mean score of thirty per cent, grade seven forty-four per cent and grade eight sixty-six per cent.

TABLE I

SKILL NUMBER ONE: READING AND WRITING NUMBERS

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	2	279	273	61	212	6	22	78	2	22
7	2	302	298	123	175	4	38	62	1	41
8	2	186	186	116	70	0	62	38	0	62
6	11	279	268	38	230	11	14	86	4	14
7	11	302	297	99	198	5	33	67	2	33
8	11	186	186	131	57	0	70	30	0	70
6	15	279	211	79	132	68	37	63	24	28
7	15	302	260	101	159	42	39	61	14	33
8	15	186	175	65	110	11	37	63	6	35
6	19	279	227	150	77	52	66	34	19	54
7	19	302	269	230	39	33	86	24	11	76
8	19	186	172	153	19	14	89	11	8	82

Cumulative Data:

		Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
Six		1116	979	323	651	137	32	68	12	29
Seven		1208	1124	553	511	84	49	51	7	46
Eight		744	719	463	256	25	64	36	7	62

The following four items were presented to test the children's skill in reading and writing numbers:

Item 2. How should two hundred twenty-two and thirteen thousandths be written?
1) 20022.13   3) 222.1300
2) 222 13000   4) 222.013

Item 11. How would you read 100.01?
1) One hundred and one.
2) One hundred and one-tenth.
3) One hundred and one-hundredth.
4) One hundred and one-thousandth.

Item 15. How many digits are used in writing the number four hundred twenty thousand seven?
1) 3   2) 5   3) 6   4) 9

Item 19.   Which of the following represents the largest
           quantity?
           1) M   2) C   3) XL   4) XII

Table I indicates that the per cent of items right
for the skill of reading and writing numbers was, for the
sixth grade, 29, for the seventh 46, and for the eighth, 62.
The sixth grade percentage was pulled down by their poor
showing on item 11. This might be caused by the fact that
the sixth grade, at this point in the school year, has had
little or no experience with decimal numbers.

The seventh grade showed a marked improvement over the
sixth grade in their knowledge of the Roman Numeral item.
They showed a slight improvement over the sixth grade in
their performance on item 15, while grade eight ranked about
the same as the seventh grade on item 15, showing a 2 per
cent increase.

The one item that ranked highest in each of the three
grades was item 19, the item pertaining to Roman Numerals.
The poorest showing, in grades seven and eight, was made on
item 15. Morton states that "...unless the number system has
been the object of a very definite attention by teachers in
the earlier grades, many of the pupils in the upper grades
may be deficient in their comprehension of the number system."[22]

Comparing the percentage scores with the mean score
in each of the three grades one finds the sixth grade right
on the mean score, the seventh grade slightly above, and the
eighth grade approximately five percentage points below.

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[22] Robert Lee Morton, Teaching Arithmetic in the
Elementary School, Volume III, Upper Grades, (New York:
Silver Burdett Company), 1939, p. 76.

TABLE II

SKILL NUMBER TWO: KNOWLEDGE OF COMMON QUANTITATIVE MEASURES

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	1	279	278	209	69	1	75	25	0	75
7	1	302	300	240	60	2	80	20	0	79
8	1	186	186	152	34	0	82	18	0	82
6	5	279	244	67	177	37	27	73	13	24
7	5	302	280	97	193	22	35	65	8	32
8	5	186	174	112	62	12	64	36	6	60
6	9	279	255	55	200	24	21	79	9	20
7	9	302	300	168	132	2	56	44	1	56
8	9	186	185	103	82	1	56	44	1	55
6	26	279	262	71	191	17	27	73	6	25
7	26	302	288	117	171	14	41	59	5	39
8	26	186	183	119	64	3	65	34	2	64
6	34	279	138	46	92	141	33	67	51	16
7	34	302	215	99	116	87	46	54	29	33
8	34	186	149	83	66	37	56	44	20	45
6	36	279	139	86	52	141	62	38	51	31
7	36	302	208	124	84	94	60	40	31	41
8	36	186	141	96	45	45	68	32	24	52
6	39	279	106	61	38	180	57	43	65	22
7	39	302	153	91	62	149	60	40	49	30
8	39	186	124	78	46	62	63	37	33	42

Cumulative Data:

Six		1953	1422	603	819	531	42	58	27	31
Seven		2114	1744	808	936	370	46	54	18	38
Eight		1302	1142	743	399	160	65	35	12	57

Table II lists the performance the pupils of the

three upper grades made on the seven items that measure

skill number two in the test. The examples following are those items which were grouped together to test the pupils' skill in their knowledge of the common quantitative measures.

Item 1. 75 minutes is how many hours?
1) 3/4   2) 1 1/4   3) 1 1/2   4) 2 1/2

Item 5. Which of these is used in measuring an angle?
1) Meters   3) Degrees
2) Cubic feet   4) Centimeters

Item 9. How many square feet are there in a square yard?
1) 3   2) 4   3) 6   4) 9

Item 26. The length of the air field runway is 1800 feet. How many miles is this?
1) Less than half a mile.   3) 1 mile.
2) 1/2 mile.   4) 2 miles.

Item 34. In what units would the volume of a box be given?
1) In centimeters   3) In degrees.
2) In square inches.   4) In cubic inches.

Item 36. Which of these is a measure of area?
1) An acre.   3) A peck.
2) A rod.   4) A cubic foot.

Item 39. If a farmer asks for the capacity of a grain bin, what units of measurement should a salesman use in answering?
1) Gallons.   3) Bushels.
2) Cubic feet.   4) Tons.

The cumulative data of Table II show that the three grades are proficient in this skill to the extent of thirty-one per cent for grade six, thirty-eight per cent for grade seven, and fifty-seven per cent for grade eight.

Each of the three grades rated highest on item one, which pertains to how many hours in seventy-five minutes. Also, their lowest items were numbers thirty-four and thirty-nine.

One might expect these two items to rank low because

the presentation of volume in the course of arithmetic study does not usually come until the latter part of grade eight.

Comparing the performance of this skill as it is found for each of the three grades on the graph shown in Figure 1, one finds that grade six lies one point above its mean percentage score while grades seven and eight fall six and nine points below.

Though each grade has shown some improvement over the previous grade, grades seven and eight have not performed comparatively as well as grade six. Grade six may have had an advantage because the instruction for quantitative measures has been most recent for this grade.

TABLE III

SKILL NUMBER THREE: KNOWLEDGE OF FIGURES, FACTS AND SYMBOLS

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	6	279	276	128	148	3	46	54	1	45
7	6	302	299	156	143	3	52	48	1	52
8	6	186	186	106	80	0	57	43	0	57
6	7	279	254	121	140	15	48	52	5	43
7	7	302	299	208	91	3	70	30	1	69
8	7	186	186	138	48	0	74	26	0	74
6	21	279	188	77	110	91	41	59	33	28
7	21	302	251	121	130	51	48	52	17	40
8	21	186	165	77	88	21	47	53	11	41
6	23	279	228	80	142	40	35	65	14	29
7	23	302	284	142	142	18	50	50	6	47
8	23	186	186	98	88	0	53	47	0	53

Cumulative Data:

		Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
Six		1116	967	427	540	149	44	56	13	38
Seven		1208	1133	627	506	75	55	45	6	52
Eight		744	723	419	304	21	58	42	3	56

Skill number three included four items to test the pupils' skill in the knowledge of figures, facts and symbols. The problems presented were:

Item   6:   Two and a half hours after midnight would be what time?
1)   12 A.M.   3)   9:30 P.M.
2)   2:30 P.M.   4)   2:30 A.M.

Item   7:   How should 5" be read?
1)   Five feet.   3)   Five inches.
2)   Five degrees.   4)   Five hours.

Item 21:   1000 B.C. is about how many years ago?
1)   1000   2) 940   3)   1940   4)   2940

Item 23:   Which is equal to 4%?
        1) 4/10   2) 1/4   3) 4/100   4) .40

The cumulative data in Table III indicate the proficiency of the pupils in their knowledge of figures, facts and symbols was thirty-eight per cent for the sixth graders, fifty-two per cent for the seventh graders and fifty-six per cent for the eighth graders. Each grade found item 21 most difficult. The seventh and eighth grades ranked highest on item 7: "How should 5" be read?" Twenty-nine per cent of the sixth graders responded correctly to item 23: "Which is equal to 4%?"

The graph comparing the skills shows this skill ranking above the mean eight points in grade six, eight points above for grade seven, but ten points below for grade eight. This fact would indicate perhaps, that the eighth grade needs further instruction in handling problems involving arithmetical facts, figures and terms.

TABLE IV

SKILL NUMBER FOUR: KNOWLEDGE OF GEOMETRIC FIGURES AND TERMS

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	10	279	260	48	212	19	18	82	7	17
7	10	302	296	120	176	6	41	54	2	40
8	10	186	183	75	108	3	41	59	2	40
6	13	279	235	114	121	44	49	51	16	40
7	13	302	289	156	133	13	54	46	4	52
8	13	186	186	148	38	0	80	20	0	80
6	14	279	231	36	195	48	16	84	17	13
7	14	302	283	47	236	19	17	83	6	16
8	14	186	181	81	100	5	45	55	3	44
6	25	279	208	122	86	71	59	41	25	43
7	25	302	264	169	95	38	64	36	13	56
8	25	186	179	143	36	7	80	20	4	77
6	27	279	199	76	123	80	38	62	29	27
7	27	302	262	111	151	40	42	58	13	37
8	27	186	184	112	72	4	61	39	2	60
6	32	279	178	79	99	101	44	56	36	28
7	32	302	252	123	129	50	49	51	17	41
8	32	186	161	63	98	25	39	61	13	34

Cumulative Data:

Six		1674	1311	475	836	363	36	64	22	28
Seven		1812	1646	726	920	166	44	56	9	40
Eight		1116	1072	620	452	44	57	43	4	56

In testing the skill of pupils on their knowledge of geometric figures and terms, the following six items were given in the test:

Item 10: How many faces or sides does a cube have?
    1) 4   2) 6   3) 8   4) 12

Item 13:   In which of these figures is there a horizontal line?

1) ✕   2) ⟨   3) ═   4) ∨
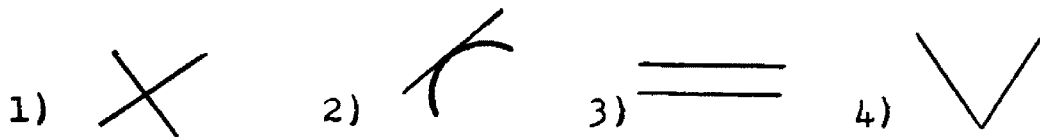
Item 14:   In which of the figures above do the lines form a right angle?
1) 1   2) 2   3) 3   4) 4

Item 25:   Which of these shows a diameter?

1) ⊘   2) ⊖   3) ⊘   4) ⊘
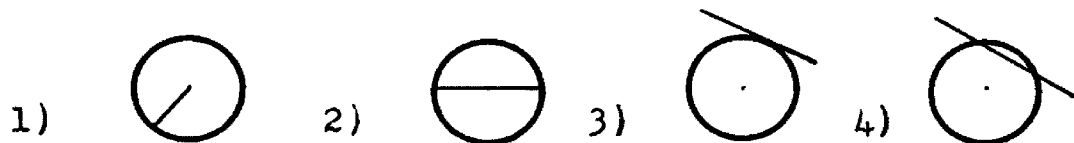
Item 27:   Which line is the circumference of the circle?

1) A
2) B
3) C
4) D
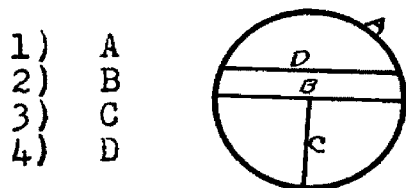
Item 32:   What is the perimeter of a rectangle?
1)   The distance around it.
2)   Its area.
3)   The distance from one corner to the opposite corner.
4)   One-half the base times the altitude.

Of the six items tested in each of the three grades, grades six and seven found item 14 most difficult. Grade eight ranked lowest on item 32. The best performances shown on the six items in grades six and seven were on item 25. Grade eight ranked highest on item 13.

Grade eight showed a slight regression in performance on item 32 as compared with grade seven, by ranking four percentage points lower than grade seven. This slight regression is probably due to the eighth graders forgetting the fact that the perimeter of a rectangle is the distance around the rectangle. This fact is stressed at some time

during the latter part of the sixth grade.

The cumulative data shown in Table IV indicate the proficiency in the pupils' knowledge of geometric figures and terms to be twenty-eight per cent in grade six, forty per cent in grade seven and fifty-six per cent in grade eight. Comparing these results with the mean for each grade, one would find each grade below: the sixth grade below two percentage points; grade seven, four percentage points; and grade eight, ten percentage points below.

TABLE V

SKILL NUMBER FIVE: ABILITY TO ESTIMATE QUANTITATIVELY

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	3	279	277	47	230	2	17	83	1	17
7	3	302	299	62	237	3	21	79	1	21
8	3	186	185	28	157	1	15	85	0	15
6	12	279	267	64	203	12	24	76	4	23
7	12	302	297	94	203	5	32	68	2	31
8	12	186	183	80	103	3	44	56	2	43
6	16	279	246	39	205	53	16	84	19	14
7	16	302	188	58	230	20	20	80	7	19
8	16	186	180	44	136	6	24	76	3	24
6	18	279	242	129	114	37	53	47	13	46
7	18	302	276	189	87	26	68	32	9	63
8	18	186	173	128	45	13	74	26	7	69
6	22	279	188	96	97	91	51	49	33	34
7	22	302	245	142	103	57	58	42	19	47
8	22	186	156	97	59	30	62	38	16	52
6	24	279	262	104	160	17	40	60	6	37
7	24	302	289	134	155	11	46	54	4	44
8	24	186	183	74	109	3	40	60	2	40
6	33	279	157	45	102	122	29	71	44	16
7	33	302	228	83	145	74	36	64	25	27
8	33	186	155	67	88	31	43	57	17	36
6	37	279	109	38	77	169	35	65	61	14
7	37	302	189	81	108	113	43	57	37	27
8	37	186	136	65	71	50	48	52	27	35
6	38	279	111	60	51	168	54	46	60	21
7	38	302	171	91	80	131	53	47	43	30
8	38	186	133	88	45	53	66	34	29	47
6	40	279	115	60	55	169	52	48	61	22
7	40	302	150	55	95	152	37	63	50	18
8	40	186	115	52	63	71	45	55	38	28
Cumulative Data:										
Six		2790	1950	682	1268	840	35	65	30	24
Seven		3020	2428	989	1439	592	41	59	20	32
Eight		1860	1599	723	876	261	45	55	14	46

Skill number five which tested pupils' ability to estimate quantitatively, contained ten different items which were as follows:

Item 3: About how high is an average dining table?
1) 2 1/2 feet   3) 4 feet
2) 3 1/2 feet   4) 5 feet

Item 12: A ton of coal is about equal in weight to how many men?
1) 4   2) 9   3) 13   4) 20

Item 16: About how many acres are in the shaded area in this diagram?

1) about 1/4
2) about 16
3) about 160
4) about 320

I mile
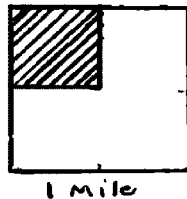
Item 18: A tree 24 feet high is about how many times as high as a tall man?
1) 2   2) 3   3) 4   4) 6

Item 22: In looking at three groups of calves, one man said, "There are 6 in the first group, 6 in the second, and 8 in the third." A second man said, "There are 20 calves." If you only wanted to know how many calves there were, why was the second man's answer best?

1) Because it is easier to think of one group of 20 than of three groups of 6, 6, and 8.
2) Because 20 tells you how many calves there were.
3) Because 20 does not leave out any of the calves.
4) Because the first man did not tell how many calves there were.

Item 24: In telling how long a certain bridge is, four children gave the following answers. Each answer is correct, but one is better than any other. Which is best?

1) About three times the distance across the school lawn.
2) About 40 times the length of this room.
3) About 12 times as far as the distance around the school room.
4) A person can run across it in about 2 minutes.

Item 33: The population of city A is 161,832; that of city B is 43,126. What is the best way of expressing the relationship between the two populations?
1) A has 118,706 more people than B.
2) A is many times larger than B.
3) A is about four times as large as B.
4) A is about six times as large as B.

Item 37: In the last election, candidate A beat candidate B "two to one." If A received about 15,000 votes, approximately how many votes did B receive?
1) 7,500   3) 30,000
2) 10,000   4) 45,000

Item 38: About how long would it take an eighth grade boy walking at a fast rate to walk a mile?
1) 5 minutes   3) 1/2 hour
2) 15 minutes   4) 1 hour

Item 40: About how many 850-pound steers can be hauled in a truck with a load limit of 5 tons?
1) 6   2) 11   3) 16   4) 20

The cumulative data indicate the performance the pupils made on the ten items in their ability to estimate quantitatively. Grade six was twenty-four per cent right, grade seven thirty-two per cent and grade eight was forty-six per cent.

The items which were most difficult for the sixth grade were items 3, 16, 33 and 27. Forty-four per cent of the sixth grade omitted item 33. Sixty-one per cent omitted item 37.

Grade six showed the best performance on items 18, 22 and 24.

The degree of performance in this skill for grade seven was pulled down by the poor accomplishment shown on items 3, 16 and 38. Grade seven was most accurate in attempts on items 18, 22 and 24.

Grade eight's performance on this skill was lowered in attempts to do items 3, 16 and 40. This grade showed the best achievement in items 18, 22 and 38.

In each grade, items 3 and 16 were most difficult, while items 18 and 22 were most accurately accomplished. One notes that children of grades six, seven and eight can estimate the height of a 24-foot tree in terms of a tall man much more accurately than they can estimate the height of a dining room table in terms of feet.

According to the graph, in estimating quantitatively, each grade falls below its overall mean. Grade six is below six percentage points, grade seven twelve percentage points and grade eight twenty percentage points.

TABLE VI

SKILL NUMBER SIX: ABILITY TO COMPARE FRACTIONS AND NUMBERS

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	4	279	271	29	234	9	11	89	3	10
7	4	302	296	144	152	6	48	52	2	48
8	4	186	185	125	60	1	68	32	0	67
6	8	279	273	20	253	6	7	93	2	7
7	8	302	299	20	279	3	7	93	1	7
8	8	186	185	34	151	1	18	82	0	18
Cumulative Data:										
Six		558	543	49	494	15	9	91	3	9
Seven		604	595	164	431	9	28	72	2	27
Eight		372	370	159	211	2	43	57	1	43

When the pupils were tested on their ability to compare fractions and numbers, the following problems were included in the test:

Item 4:   Which of these represents the largest value?
1) .6   2) .400   3) .3841   4)   .0893

Item 8:   Which of these fractions is the largest?
1) 5/12   2) 11/18   3) 12/25   4) 1/3

Table VI indicates the performance the pupils made in their ability to compare fractions and numbers. Of the two items tested in this skill, number 4 was more accurately done by each of the three grades. However, in grade six, the difference was slight.

Item 8 might have been accomplished more accurately had choices two and three been more familiar common fractions.

Comparing the results of this skill with each grade's mean, one notes grade six below twenty-one percentage points, grade seven below seventeen points, and grade eight below twenty-three points.

TABLE VII

SKILL NUMBER SEVEN: KNOWLEDGE OF THE NUMBER SYSTEM

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	20	279	207	107	100	72	52	48	26	38
7	20	302	261	194	77	41	74	26	14	58
8	20	186	170	139	31	16	82	18	9	75
6	28	279	268	168	100	11	63	37	4	60
7	28	302	296	217	79	6	73	27	2	72
8	28	186	185	129	56	1	70	30	0	69
6	29	279	259	110	149	20	42	58	7	39
7	29	302	290	171	119	12	59	41	4	57
8	29	186	182	116	66	4	64	37	2	62
6	31	279	230	120	110	149	52	48	53	43
7	31	302	271	145	126	31	54	46	10	48
8	31	186	175	102	73	11	58	42	6	55

Cumulative Data:

Six		1116	864	505	359	252	58	42	23	45
Seven		1208	1118	717	401	90	64	36	11	59
Eight		744	712	46	226	32	68	32	4	65

Skill number seven included four items to test the pupils' skill in the knowledge of the number system. The problems presented were:

Item 20: Why do we write the zero in 3.05?
1) Because arithmetic books say we should.
2) Because it holds the tenths place and shows that the 5 means 5 one-hundredths.
3) Because it shows that there are no fractions in the numbers.
4) Because the tenths place is always a zero when there are hundredths in a number.

Item 28:   In which number does the 3 represent hundreds?
1) 431   2) 3826   3) 5319   4) 300000

Item 29:   In the number 555, how does the first 5 compare
in value with the last 5?
1) It is the same.
2) It is twice as great.
3) It is 10 times as great.
4) It is 100 times as great.

Item 31:   In the word "eighty-one," what does the "ty" mean?
1) It is used to make the word sound rhythmical.
2) It means tens.
3) It means to add 80 and 1 together.
4) It means less than nine and more than eight.

Data pertaining to the pupils' knowledge of the number system are shown in Table VII. Considering the cumulative percentages, grade six was forty-five per cent right, grade seven fifty-nine per cent right, and grade eight sixty-five per cent right. The item which tended to pull down the percentages in each grade was item 20 in grade six and item 31 in grades seven and eight. Grade six has had little experience with decimals at this point in the school year; therefore, many did not know why the zero is placed in the decimal 3.05. Grades seven and eight evidently had forgotten some of their training in the number system when they failed to know what "ty" in the word "eighty" meant.

The best performance shown on any one of the four items was noted on item 28 for grades six and seven. Grade eight ranked highest on item 20.

The results on item 28 show a slight regression in grade eight as compared with grade seven. This may be explained by the fact that the training in the number system is more recent to grade seven.

Grades six and seven rank fifteen percentage points above their mean percentage scores. Grade eight falls one percentage point below its mean. The fact that grade eight has not maintained its position as compared with grades six and seven may be reason to offer review and continued instruction in facts about our number system in grade eight.

TABLE VIII

SKILL NUMBER EIGHT: KNOWLEDGE OF COMMON PROCESSES

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	17	279	244	29	215	35	12	88	13	10
7	17	302	279	84	189	29	31	69	10	28
8	17	186	162	59	103	24	36	64	13	32
6	30	279	230	53	177	49	23	77	18	19
7	30	186	279	71	208	23	25	75	8	24
8	30	186	178	56	112	8	31	69	4	30
6	35	279	97	27	70	182	27	73	65	10
7	35	186	167	37	130	135	22	78	45	12
8	35	186	131	26	105	55	20	80	30	14
Cumulative Data:										
Six		837	571	109	462	266	19	81	32	13
Seven		906	719	192	527	187	27	73	21	21
Eight		558	471	151	320	87	32	68	16	27

In testing the skill of pupils in their knowledge of common processes, the following three items were given in the test:

Item 17: How many 1/6's are in 2/3?
1) Less than one.   3) 3
2) 2   4) 4

Item 30: Which of these figures shows what 1/4 x 1/2 equals?

Item 35: In which of these situations would π be used?
(π = 3.14)
1) In finding the thickness of a tree.
2) In finding the area of a triangle.
3) In finding the perimeter of a hexagon.
4) In finding the volume of a cube.

Table VIII presents data of the three items that were tested, and the cumulative data found in evaluating the skill in the knowledge of common processes.

The skill data reveal the sixth grade was thirteen per cent accurate, grade seven twenty-one per cent and grade eight twenty-seven per cent. Each grade was hampered in its degree of proficiency on this skill by item 35, which requires the pupil have a knowledge of "pi." The fact that children did poorly on this item may be explained because instruction in the use of "pi" does not usually come until the later part of grade eight.

Grade six made its best showing on item 30, while grades seven and eight did their best on item 17.

Each grade falls far below its own mean percentage score. Grade six fell below twenty points, grade seven fell twenty-three points, and grade eight fell thirty-nine points.

This skill was suggested by the testing company. Possibly a better title could have been chosen because the items did not seem to test a pupil's knowledge of common processes. Possibly the items would have been better placed in other skills.

TABLE IX

SKILL NUMBER NINE: BASIC ADDITION

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	41	279	243	220	23	36	91	9	13	79
7	41	302	296	275	21	6	93	7	2	91
8	41	186	184	174	10	2	95	5	1	94
6	45	279	274	191	83	5	70	30	2	68
7	45	302	299	248	51	3	83	17	1	82
8	45	186	185	160	25	1	86	14	0	86

Cumulative Data:

Six		558	517	411	106	41	79	21	7	74
Seven		604	595	523	72	9	88	12	2	87
Eight		372	369	334	35	3	91	9	1	90

Skill number nine included only two items to test the skill of pupils in basic addition:

Item 41: Add: 706
                  394
                  817

Item 45: Add: 4
                  16
                  20
                   7
                  15
                   9
                  30
                  31

The table above indicates the results found in relation to the pupils' reaction to the two problems of addition.

Each grade showed a slightly better degree of performance in finding the sum of the numbers in item 41 than in item 45. The reason probably being because of the shortness of the columns.

The cumulative data indicate two apparent facts:
one, that the greatest amount of improvement came in grade
seven, and two, only a slight improvement was shown by grade
eight over grade seven.

The graph comparing the percentage scores for the
twenty-two skills shows each grade was most proficient in
basic addition. Grade six exceeded its mean score forty-
four percentage points, grade seven exceeded its mean score
forty-three points, while grade eight ranked above the
eighth grade mean score by twenty-four points.

TABLE X

SKILL NUMBER TEN: BASIC SUBTRACTION

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	42	279	278	170	108	1	61	39	0	61
7	42	302	298	224	74	4	75	25	1	74
8	42	186	184	137	47	2	74	26	1	74
6	46	279	272	216	56	7	79	21	3	77
7	46	302	297	263	34	5	89	11	2	87
8	46	186	186	169	17	0	91	9	0	91
Cumulative Data:										
Six		558	550	386	164	8	70	30	1	69
Seven		604	595	487	108	9	82	18	2	81
Eight		372	370	306	64	2	83	17	1	82

Skill number ten included these two items to test the skill of pupils in basic subtraction:

Item 42: Subtract 3005
                     2919

Item 46: Subtract 4730
                     2089

The performance made by the pupils of the three grades in subtraction is displayed in Table X. In each grade, the children were able to accomplish item 46 more accurately than item 42. The two zeros found in the minuend of item 42 may have been the reason for the increased number of errors.

The skill of basic subtraction, as the cumulative data indicate, is most improved in grade seven. Grade eight showed only one percentage point above grade seven, while grade seven showed an improvement of twelve points. Grade

seven has had the benefit of the concentrated instruction provided in grade six. Grade eight children have maintained their abilities in this skill but have made little improvement over their previous year's work.

According to the graph of comparative percentage scores, the proficiency in subtraction is slightly lower than the proficiency in the addition skill. The children of grade six were thirty-nine percentage points above their mean score, grade seven was above thirty-seven and grade eight children were above sixteen percentage points.

TABLE XI

SKILL NUMBER ELEVEN: BASIC MULTIPLICATION

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	43	279	274	230	44	5	84	16	2	82
7	43	302	300	264	36	2	88	12	1	87
8	43	186	185	159	26	1	86	14	0	85
6	47	279	277	167	108	4	60	40	1	59
7	47	302	293	220	73	9	75	25	3	73
8	47	186	185	143	42	1	77	33	0	77

Cumulative Data:

Six		558	549	397	152	9	72	28	2	71
Seven		604	593	484	109	11	82	18	2	80
Eight		372	370	302	68	2	82	18	1	81

Skill number eleven included the following two items
to test the skill of pupils in basic multiplication:

Item 43:   Multiply   217
                       200

Item 47:   Multiply   3020
                       807

A comparison of the performance on the two basic
multiplication items is shown in Table XI.

Each grade was more accurate in finding the product
of the numbers in item 43 than in item 47. There may be a
number of reasons for this fact, but one of the reasons
probably is because of the simpler multiplier in item 43.

Considering the two items as a skill, the cumulative
data showed a very slight improvement of one percentage
point for grade eight over grade seven and an improvement of

nine percentage points of grade seven over grade six.

Each of the grades ranked well above its mean score.
Grade six by forty-one points, grade seven by thirty-six
points and grade eight by fifteen points.

TABLE XII

SKILL NUMBER TWELVE: BASIC DIVISION

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	44	279	248	193	55	31	78	22	11	69
7	44	302	289	214	75	13	74	26	4	71
8	44	186	184	126	58	2	68	32	1	67
6	48	279	229	111	118	50	48	52	18	40
7	48	302	288	192	96	14	67	33	5	64
8	48	186	183	152	31	3	83	17	2	82
Cumulative Data:										
Six		558	477	304	173	81	64	36	15	54
Seven		604	577	406	171	27	70	30	4	67
Eight		372	367	278	89	5	76	24	1	75

Skill number twelve included these two items to test skill in basic division:

Item 44:   Divide $52\overline{)\,1072}$ Item 48:   Divide $85\overline{)\,3230}$

Table XII records the data pertaining to the perfor-mances of each of the three grades in finding the quotients to the numbers of items 44 and 48.

Grades six and seven found item 44 easier than item 48.   Of the three grades tested, grade eight ranked lowest in the degree of accuracy in accomplishing item 44, falling two percentage points behind grade six and four points be-hind grade seven.

The cumulative data which groups the two items into

an analysis for the skill of basic division showed some improvement each for successive grades, with the greatest improvement coming in grade seven over grade six.

The graph of comparative percentage scores shows the scores to fall above the mean score for each grade. Grade six was up twenty-four points, grade seven twenty-three points and grade eight up nine.

Of the four fundamental skills of addition, subtraction, multiplication and division, each grade ranked highest in addition and lowest in division.

TABLE XIII

SKILL NUMBER THIRTEEN: ADDITION OF FRACTIONS

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	49	279	264	217	47	15	82	56	5	77
7	49	302	296	230	66	6	78	22	2	76
8	49	186	185	170	15	1	92	8	0	91
6	53	279	225	165	60	54	73	27	19	59
7	53	302	279	216	63	23	77	23	8	72
8	53	186	186	153	33	0	82	18	0	82
6	57	279	176	18	158	103	10	90	37	6
7	57	302	255	120	135	47	47	53	16	40
8	57	186	184	136	48	2	74	26	2	73
Cumulative Data:										
Six		837	665	400	265	172	60	40	21	48
Seven		906	830	566	264	76	68	32	9	62
Eight		558	555	459	96	3	83	17	1	82

Skill number thirteen which tested ability in the addition of fractions, contained three items which were as follows:

Item 49:   Add   5/6
                  2/6

Item 53:   Add   5 5/6
                 7 2/3

Item 57:   Add   3 2/3
                 1/8
                 4 2/3

An analysis of the performances on these items is recorded in Table XIII.

The most difficult item for each grade was number 57, ranging from six per cent right for grade six, to seventy-three per cent right for grade eight.

The easiest item was number 49. Grade six made a one percentage point better score than grade seven. No reason seems apparent for this.

The cumulative data for this skill indicate improvement in each grade. Grade seven ranked fourteen percentage points over grade six, while grade eight ranked twenty points over grade seven.

Each grade ranked well above its mean score on the comparative graph. Grade six was above eighteen points, grade seven was above eighteen points and grade eight was above sixteen points.

TABLE XIV

SKILL NUMBER FOURTEEN: SUBTRACTION OF FRACTIONS

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	50	279	252	27	225	27	11	89	10	10
7	50	302	283	145	138	19	51	49	6	48
8	50	186	184	133	51	2	72	28	1	72
6	54	279	214	47	167	65	22	78	23	17
7	54	302	286	165	121	16	58	42	5	55
8	54	186	183	147	36	3	80	20	2	79
6	58	279	143	21	122	136	15	85	49	8
7	58	302	236	107	129	66	45	55	22	35
8	58	186	180	139	41	6	77	23	3	75
6	61	279	130	13	117	149	10	90	53	5
7	61	302	222	119	103	80	54	46	26	39
8	61	186	174	127	47	12	73	27	6	68
6	62	279	133	13	120	146	9	91	52	5
7	62	302	208	140	168	94	67	33	31	46
8	62	186	173	143	30	13	83	17	7	77

Cumulative Data:

Six		1395	872	121	751	523	14	86	37	9
Seven		1510	1235	576	659	275	47	53	18	38
Eight		930	894	689	205	36	77	23	4	74

Skill number fourteen which tested ability to sub-
tract fractions included a few more problems than the test
given in the addition of fractions. These items were:

Item 50: Subtract   Item 54: Subtract   Item 58: Subtract

| 42 |
| 5 1/3 |

| 8 1/3 |
| 7 2/3 |

| 13 7/8 |
| 5 1/6 |

Item 61: Subtract
          10 5/8
          <u>1 7/8</u>

Item 62: Subtract
          31
          <u>29 3/4</u>

Of the five items grouped into the above skill, number 54 was most accurately accomplished by each of the three grades. Grade six has had little experience in subtracting fractions at this point in the school year, and ranked as low as five per cent accurate on items 61 and 62. Grade seven ranked low on item 58, while grade eight scored a low of sixty-eight per cent on item 61.

As a skill, the cumulative data showed that the sixth grade accomplished only nine per cent of the five items correctly.

Grade six and seven ranked below their own mean scores. Grade six was below twenty-one points and grade seven was below six points. Grade eight ranked eight percentage points above its mean score on this skill.

TABLE XV

SKILL NUMBER FIFTEEN: MULTIPLICATION OF FRACTIONS

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	51	279	199	66	133	80	33	67	29	24
7	51	302	185	178	7	1	96	4	0	96
8	51	186	282	199	83	20	71	29	7	66
6	55	279	171	39	132	108	23	77	39	14
7	55	302	254	117	137	48	46	54	16	39
8	55	186	182	167	15	4	92	8	2	90
6	59	279	75	15	60	204	20	80	73	5
7	59	302	203	84	119	99	41	59	33	28
8	59	186	179	147	32	7	82	18	4	79
Cumulative Data:										
Six		837	445	129	325	392	27	73	47	14
Seven		906	739	400	339	167	54	46	18	44
Eight		558	546	492	54	12	90	10	2	88

Skill number fifteen tested the ability of the pupils to multiply fractions. The problems in this test were:

Item 51: Multiply
2/3 x 1/2 =

Item 55: Multiply
12 x 2 1/3 =

Item 59: Multiply
2/3 x 1 1/2 x 3/4 =

The statistics that were gathered as a record of the performance each grade made on the three items used to test multiplication of fractions may be noted in Table XV.

Each grade accomplished item 51 most accurately, and found item 59 most difficult. Seventy-three per cent of the

pupils in grade six omitted item 59. The probable reason for so many omissions is because of the three multipliers rather than the usual two that are most familiar to pupils of this grade.

As a skill, grade six accomplished successfully only fourteen per cent of the items, while grade eight scored eighty-eight per cent right.

The graph recording the comparative scores indicates that this skill ranked second high for grade eight and is twenty-two points above the grade eight mean score. While grade seven's score fell exactly on the seventh grade's mean, grade six fell sixteen points below the grade six mean. The greatest amount of improvement was shown by grade eight over grade seven.

TABLE XVI

SKILL NUMBER SIXTEEN: DIVISION OF FRACTIONS

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	52	279	126	14	112	153	11	89	55	5
7	52	302	251	86	165	51	34	66	17	28
8	52	186	185	159	26	1	86	14	0	96
6	56	279	105	28	77	174	27	73	62	10
7	56	302	232	113	119	70	49	51	23	37
8	56	186	182	154	28	4	85	15	2	83
6	60	279	68	9	59	211	13	87	76	4
7	60	302	181	69	112	121	38	62	40	23
8	60	186	180	141	39	6	78	22	3	76
6	63	279	61	8	53	218	13	87	78	3
7	63	302	153	50	103	149	33	67	49	17
8	63	186	169	120	49	17	71	29	9	65

Cumulative Data:

Six		1116	360	59	301	756	16	84	68	5
Seven		1208	817	318	499	391	39	61	32	26
Eight		744	716	574	142	28	80	20	4	77

To test the pupils' ability to divide fractions, the following items were presented in this skill:

Item 52: Divide
9 ÷ 3/4 =

Item 56: Divide
7/12 ÷ 1/6 =

Item 60: Divide
6 1/5 ÷ 2/5 =

Item 63: Divide
8 1/2 ÷ 2/3 =

Table XVI includes the information that was found about the performance each of the three grades made in the

attempt to divide fractions. This information noted that each grade found item 63 most difficult of the four items testing division of fractions. While grades six and seven found item 56 most easy, grade eight ranked highest on item 52.

The cumulative data indicate that only five per cent of the sixth grade pupils accomplished the items in this skill accurately, while grade eight scored seventy-seven per cent right. Grade six omitted sixty-eight per cent of the items while grade eight omitted only four per cent.

Grades six and seven fell below their mean scores in this skill. Grade six was down twenty-five percentage points and grade seven was down eighteen points. Grade eight exceeded its mean score by eleven percentage points.

TABLE XVII

SKILL NUMBER SEVENTEEN: MULTIPLYING DECIMALS

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	64	279	258	51	207	21	20	80	8	18
7	64	302	288	96	192	14	33	67	5	32
8	64	186	184	135	49	2	73	27	1	73
Cumulative Data:										
Six		279	258	51	207	21	20	80	8	18
Seven		302	288	96	192	14	33	67	5	32
Eight		186	184	135	49	2	73	27	1	73

The following problem was given in the test to determine the pupils' ability to multiply decimals:

Item 64:   Multiply .66 by .12.

The data for the skill of multiplying decimals were recorded in Table XVII. Grade six has little experience with the division of decimals at this point in formal education, consequently a low degree of performance may be expected. Although grade eight ranked seven points above its mean score, grades six and seven fell below the mean score for each of these two grades by twelve percentage points.

TABLE XVIII

SKILL NUMBER EIGHTEEN: DIVISION OF DECIMALS

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	65	279	235	4	231	44	2	98	16	1
7	65	302	282	22	260	20	8	92	7	7
8	65	186	184	93	91	2	51	49	1	50
Cumulative Data:										
Six		279	235	4	231	44	2	98	16	1
Seven		302	282	22	260	20	8	92	7	7
Eight		186	184	93	91	2	51	49	1	50

The following problem was given in the test to determine the pupils' ability in the division of decimals:

Item 65: Divide 244 by .02.

Table XVIII includes the data for the one item that was presented in the test to discover the pupils' ability to divide decimals.

While one per cent of grade six children marked this item correctly, fifty per cent of the eighth grade pupils were accurate. The seventh grade students were slightly more accurate than the sixth grade children by six per cent.

Instruction in the division of decimals does not usually come in the arithmetic course of study until the latter portion of the seventh year, therefore, poor performance was to be expected.

Comparing this skill with the other twenty-one listed in this study, one finds that grades six and seven ranked lowest of all skills tested. Grade six fell twenty-nine points below its mean score while grade seven fell below its mean by thirty-seven points. Grade eight was below by sixteen percentage points.

TABLE XIX

SKILL NUMBER NINETEEN: FINDING A PER CENT OF A NUMBER

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	66	279	196	32	164	83	16	84	30	11
7	66	302	263	55	208	39	21	79	13	18
8	66	186	183	106	77	3	58	42	2	57
6	68	279	178	21	157	101	12	88	36	6
7	68	302	233	19	214	69	8	92	23	6
8	68	186	183	92	91	3	50	50	2	49
6	73	279	157	14	143	122	9	91	44	5
7	73	302	227	31	196	75	14	86	25	10
8	73	186	179	71	108	7	40	60	4	38

Cumulative Data:

Six		837	531	67	464	306	13	87	37	8
Seven		906	723	105	618	183	15	85	20	12
Eight		558	545	269	276	13	49	51	2	48

Skill number nineteen included 3 items to test pupils' ability in finding a per cent of a number. The following problems were used:

Item 66:   What is 20% of 400?

Item 68:   What is 200% of $250?

Item 73:   What is 5% of $892.60?

A record of the performance the pupils have shown on the three items that were grouped to test how well pupils can find a per cent of a number is to be noted in Table XIX.

Each grade made its best score on item 66.   Poorest

scores were shown on item 73 in grades six and eight. Item 68 ranked lowest for grade seven.

All the percentage scores for each of the three items in grades six and seven were low, which may be expected since pupils of these two grades have not had formal instruction in the finding of percentage of numbers up to this point in their school lives.

The graph of comparative scores showed that this skill ranked as one of the lowest for grades six and seven. Grade six fell twenty-two points below the mean score for grade six. Grade seven fell thirty-two points below grade seven's mean and grade eight fell below by eighteen points.

TABLE XX

SKILL NUMBER TWENTY: FINDING ONE HUNDRED PER CENT WHEN A PER CENT IS GIVEN

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	67	279	176	98	78	103	56	44	37	35
7	67	302	247	122	125	55	49	51	18	40
8	67	186	183	140	43	3	77	23	2	75
Cumulative Data:										
Six		279	176	98	78	103	56	44	37	35
Seven		302	247	122	125	55	49	51	18	40
Eight		186	183	140	43	3	77	23	2	75

Skill number twenty was measured by one problem as follows:

Item 67: 16 is 50% of what number?

Table XX shows the results each grade made on the one item that was presented in the test to discover the ability of students of the three grades to find one hundred per cent when a percentage is given.

Although sixth and seventh grade pupils have not usually been exposed to the formal training of percentage they have shown some degree of ability to handle this percentage item. The fact that the familiar term of fifty per cent was used may be the reason for some of the pupils of grades six and seven being able to mark the correct response.

Each grade except grade seven, ranked above its mean

score on this skill. Grade six was above five points, grade eight was above nine points, while grade seven fell below its mean score four percentage points.

TABLE XXI

SKILL NUMBER TWENTY ONE: EXCHANGING FRACTIONS AND PER CENT

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	69	279	171	44	127	108	26	74	39	16
7	69	302	253	118	135	49	47	53	16	39
8	69	186	183	168	15	3	92	8	2	90
6	72	279	145	75	70	134	52	48	48	27
7	72	302	242	139	102	60	58	42	20	46
8	72	186	181	154	27	5	85	15	3	83
Cumulative Data:										
Six		558	316	119	197	242	38	62	43	21
Seven		604	495	238	257	109	48	52	18	39
Eight		372	364	322	42	8	88	12	2	87

Skill number twenty-one which tested pupils' ability in the exchanging of fractions and per cent, included the following two problems:

Item 69:   Change 3/4 to per cent form.

Item 72:   Change 90% to a common fraction and reduce it to its lowest terms.

In Table XXI was recorded the information pertaining to the performance each grade made on each of the two items testing the pupils' ability to exchange fractions and percentages. Of the two items, grades six and seven rated better on item 72.

Because grade eight pupils have had training in exchanging numbers and percentages during the latter part of

grade seven, they ranked very high in this skill. Their score in this skill lies eleven percentage points above the eighth grade mean score. Grades six and seven have not had the benefit of previous instruction, consequently their scores fall below their mean score. Grade six was down nine points while grade seven was down five points.

TABLE XXII

SKILL NUMBER TWENTY TWO: EXCHANGING DECIMALS AND PER CENT

Grade	Item Number	Pupils Tested	Attempts	Number Right	Number Wrong	Number Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
6	70	279	169	43	126	110	25	75	39	15
7	70	302	243	51	192	59	21	79	20	17
8	70	186	184	82	102	2	45	55	1	44
6	71	279	156	87	69	123	55	45	44	31
7	71	302	252	160	92	50	63	37	17	53
8	71	186	184	165	19	2	90	10	1	89
Cumulative Data:										
Six		558	325	130	195	233	40	60	42	23
Seven		604	495	211	284	109	43	57	18	35
Eight		372	368	247	121	4	66	34	1	66

This skill was tested by two problems, as follows:

Item 70:   Change .495 to per cent form.

Item 71:   Change 76% to decimal form.

The table at the top of the page indicates how well children in grades six, seven and eight have done in exchanging decimals with percentages.   In the two items tested, number 71 was less difficult.

As the cumulative data show, grade six was twenty-three per cent proficient in this skill.   One factor that accounts for such a low score was the omission of forty-two per cent of the items testing this skill.

Because grades six and seven have had little exper-
ience in exchanging decimals with percentages, their scores
have fallen below their mean score. Grade six was down
seven percentage points, grade seven was below its mean
score nine points, while grade eight's score coincides
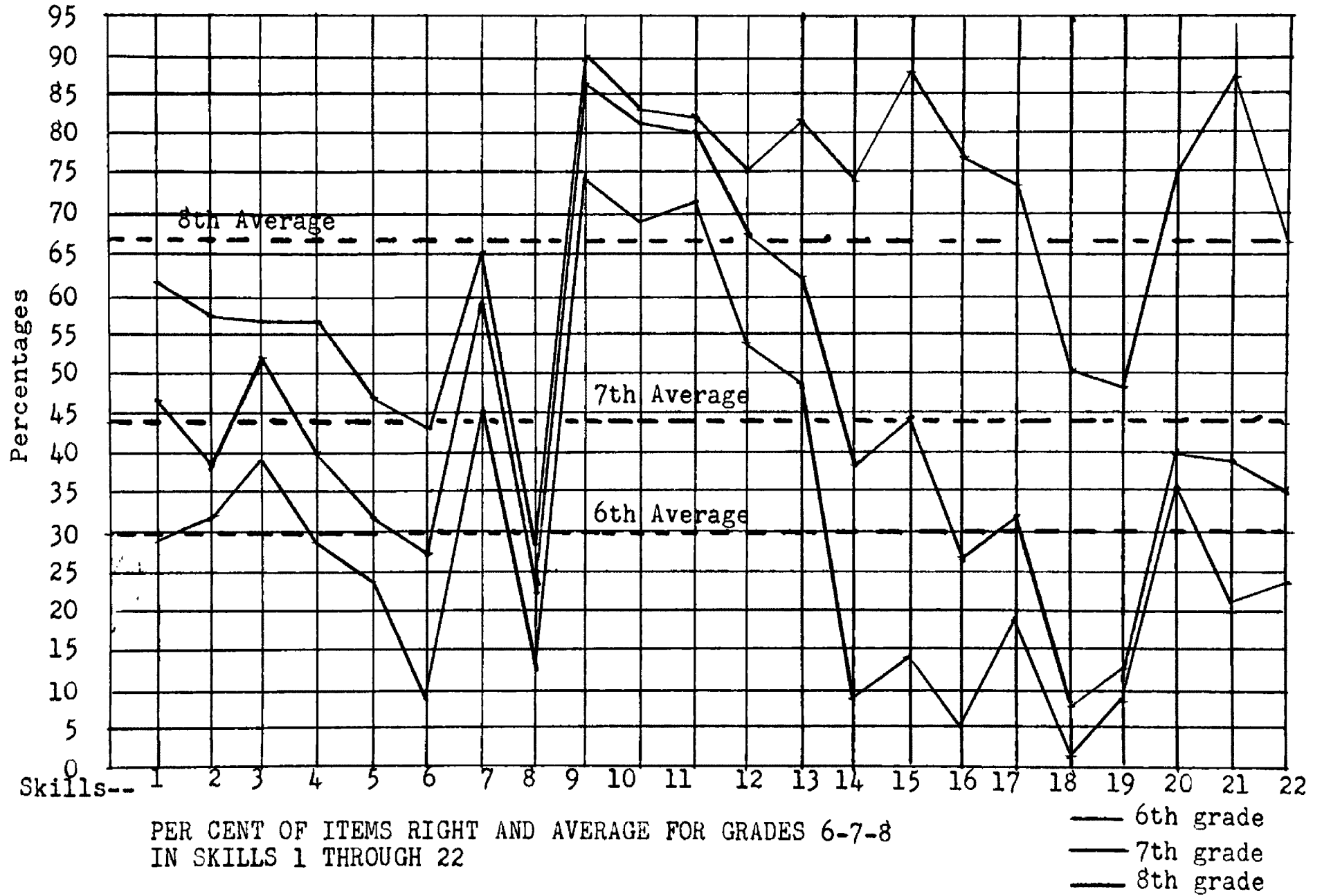exactly with its mean score.

LIST OF SKILLS

The list of skills may be found on the following page opposite the chart showing the performance of each grade in each of the skills tested.

LIST OF SKILLS

1. Reading and writing numbers

2. Knowledge of common measures

3. Knowledge of facts figures and terms

4. Knowledge of geometric facts and terms

5. Ability to estimate quantitatively

6. Ability to compare fractions and numbers

7. Knowledge of the number system

8. Knowledge of common processes

9. Basic addition

10. Basic subtraction

11. Basic multiplication

12. Basic division

13. Addition of fractions

14. Subtraction of fractions

15. Multiplication of fractions

16. Division of fractions

17. Multiplication of decimals

18. Division of decimals

19. Finding a per cent of a number

20. Finding the whole when a per cent is given

21. Exchanging fractions and percentages

22. Exchanging decimals and percentages

FIGURE I

PER CENT OF ITEMS RIGHT AND AVERAGE FOR GRADES 6-7-8
IN SKILLS 1 THROUGH 22

—— 6th grade
—— 7th grade
—— 8th grade

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to find information in two areas. First, to present the results of a diagnostic test in a manner that valuable data pertinent to performance in arithmetic skills utilized by sixth, seventh, and eighth graders could be analyzed. This was accomplished in part through suggestions from the testing company. The remainder of the analysis was an arbitrary grouping of items into skills which each item seemed best to test. Secondly, this study was an attempt to find the actual performance made on seventy-three different items by two hundred seventy-nine sixth grade, three hundred two seventh grade, and one hundred eighty-seven eighth grade pupils.

The actual performance and proficiency of the pupils of the three grades is shown in twenty-two tables and one comparative graph.

As a result of this study certain general and specific conclusions seemed evident. The general conclusions discussed are those which seemed to be most revealing about the test as a whole. The specific conclusions pertain to each of the twenty-two skills measured by the diagnostic test.

The recommendations offered in this chapter were presented so that teachers or interested persons might have some assistance and guidance in grades or skills applicable

to their area of work.

Unless the results of this study are used to improve the proficiency of pupils in arithmetic skills, much of its value will be lost.

The general conclusions are those which were found about the results of the whole test. Some of these are:

1. The test used tested the three grades: grade six, grade seven and grade eight. Thus, this instrument has too wide a range to be very effective in any one grade, that is, if the test is reliable for fifth graders, it would seem unreliable for ninth graders. A great number of items are much too difficult for eighth graders and therefore would be beyond the comprehension of sixth graders.

2. The materials tested often do not conform to the grade placement of materials found in the arithmetic curriculum. To attempt to test children on items beyond their comprehension and experience is probably a waste of time.

3. The skill of reading becomes a factor that has a definite bearing on the student's ability to do arithmetic. This factor was not taken into consideration. Therefore, to say that errors in arithmetic were due to lack of skills in arithmetic may not be a sound deduction.

4. Another conclusion is apparent in the fact that in no one skill was there sufficient items to test any one of the skills completely. Only indications are obtainable. The average number of items per skill is five for Part I. In Part II there are about two and one-half items per skill.

The average number of items per skill for the two parts is three and one-third items. Skills number 17, 18 and 20 were tested by one item. Skills 6, 9, 10, 11, 12 and 21 were tested by two items. Skill number 5 was tested by ten items.

5. The testing company was unable to provide statistics comparable to the results of this study, therefore, it was impossible to weigh the results of the Missoula pupils with another measure.

6. Norms for each grade and each skill were not available. The results of this test may be used as a basis later should the test be given again in Missoula's Public Schools.

7. There seemed to be little if any correlation between the number of omits and the number of errors.

8. No skills were completely mastered by the end of the first month of the eighth grade and therefore further instruction is needed if complete mastery is desirable.

The specific conclusions are those which are shown by the results found in each of the twenty-two skills. Some of these are:

1. Reading and Writing of Numbers

    a. Instruction should continue through the eighth grade.

    b. There is a need for more instruction in the area of digits and number place value in large numbers even in the eighth grade.

2. Knowledge of Common Measures

    a. The evidence shows a need for continuing the

instruction in common measures through the eighth grade.

b. The instruction should be directed toward practical application of the use of the common measures.

3. Knowledge of Figures, Facts and Symbols

a. There is need to continue the instruction in the use of figures, facts and symbols throughout the eight grades.

b. More effort should be placed on the instruction in the computing of time in terms of years.

4. Knowledge of Geometric Figures and Terms

a. Of the figures tested, children of grades six, seven and eight are most familiar with circles.

b. Some of the material covered in the test is unfamiliar to sixth graders.

c. There is a need for continuing the instruction in geometric figures and terms through grade eight.

5. Ability to Estimate Quantitatively

a. The proficiency in this skill seems rather low in comparison to other skills.

b. There seems to be a need for more instruction and practical application of instruction in this skill.

c. Children of the sixth grade omitted thirty per cent of the items, probably because of their unfamiliarity with the vocabulary of the test.

6. Ability to Compare Fractions and Numbers

a. The sixth grade should not be tested in this area in October.

b. Seventh and eighth graders need further instruction in their judgment of sizes of decimal and common fractions.

c. The item used to test the ability to compare size of common fractions was not practical, since unfamiliar fractions were used.

d. The results showed that there was a low percentage of right answers, however few items were omitted.

7. Knowledge of the Number System

a. There is a definite need for further instruction in this skill.

b. The sixth grade did reasonably well considering the unfamiliar items found in the test.

c. Seventh and eighth graders need to be given more training in their use of "ty" in their vocabulary of numbers.

8. Knowledge of Common Processes

a. The title of this skill is misleading because the items listed to test this skill do not seem to measure knowledge of common processes.

9. Basic Addition

a. There is definite improvement shown each year as the children progress through school.

b. While the eighth grade is ninety per cent accurate in the items tested, there is still need for more instruction and drill if complete mastery is desired.

10. Basic Subtraction

a. Children in Missoula's Public Schools have difficulty in subtracting where "borrowing" is necessary and where there are zeros in the subtrahend.

b. The results show that the children made a few more errors in the items of subtraction than they did in the items of addition.

c. There still is need for more practice in subtraction if mastery of the skill is desirable.

11. Basic Multiplication

a. There seemed to be a slight improvement in

the skill of eighth graders over seventh graders.

b. The eighth grade is still eighty-one per cent accurate in the multiplication items tested. There is a continued need for more perfection in this skill.

12. Basic Division

a. The children of Missoula's Public Schools found the items for the division skill more difficult to accomplish successfully than any of the four basic fundamental skills.

b. Sixth graders omitted fifteen per cent of the items, probably because of the difficulty of the items and because of the time it takes to accomplish division items.

13. Addition of Fractions

a. The three grades were able to add the fractions with common denominators best.

b. There is need for further practice and instruction in this skill even in the eighth grade.

c. There was about twenty per cent improvement each year as the children progress through grades six, seven and eight.

14. Subtraction of Fractions

a. Because the sixth grade was only nine per cent right there would seem to be no reason to test sixth graders by the items found in the test.

b. Subtraction of fractions, as tested, was more difficult than addition of fractions, as tested.

15. Multiplication of Fractions

a. The sixth grade should not be tested on multiplication of fractions at this time of the school year.

b. The eighth grade had a higher percentage of right responses in this skill than it did in the other three fundamental processes of skills in fractions.

16. Division of Fractions

    a. Sixth graders are not expected to do any division of fractions at this point of the school year, therefore, the results for the sixth grade were very low.

    b. The seventh graders have had little experience in this skill at this point in the school year. They have improved but slightly over the sixth graders.

    c. The eighth graders should have further instruction in this skill if they are expected to master it.

17. Multiplication of Decimals

    a. Only one item was offered to test this skill. From the results one notes there is need for further instruction in the multiplication of decimals. Even though the sixth graders had but eighteen per cent right, they omitted only eight per cent, which indicates there is little relationship between the per cent right and the per cent omitted.

18. Division of Decimals

    a. This skill was tested by only one item. It would seem that the skill of division of decimals ought to be tested by a number of different items.

    b. The sixth and seventh grades should not be expected to be tested on items of this nature.

    c. Before students of Missoula's Public Schools complete the eighth grade they should have further instruction in dividing decimals.

19. Multiplication of Decimals

    a. Because of the single item that was offered to test this skill, it seems that no valid conclusion can be made except to mention that the sixth grade should not be expected to perform this operation, and that the eighth grade is seventy-three per cent accurate and in need of more training if mastery is desirable.

20. Finding One Hundred Per Cent When a Per Cent is Given

    a. Because only one item was offered to test this skill, there can hardly be any conclusion other than the fact some children of these three grades do have some concept of what fifty per cent means.

21. Finding a Per Cent of a Number

    a. This particular skill is unfamiliar to sixth and seventh grade pupils. They have done poorly in this skill.

    b. There is evidence that the seventh grade instruction and practice has given pupils of the eighth grade enough experience to accomplish correctly forty-eight per cent of the items.

    c. To become completely proficient in the items tested, the eighth grade will need more instruction and practice.

22. Exchanging Decimals and Per Cents

    a. It may be concluded that children of the three grades tested have some idea of exchanging decimals and per cents but even by the time they reach the first month of the eighth grade, they are only sixty-six per cent accurate.

    b. Because the sixth graders did not know how to accomplish these items, they were not hesitant in leaving them out.

RECOMMENDATIONS

On the basis of the results of the testing that was done in the arithmetic skills by the Iowa Every Pupil Test of Basic Skills there are a number of recommendations that can be made. A few of these recommendations are:

1. There should be at the outset of each school year, a meeting of teachers from each of the upper four

grades. The purpose of each of these grade meeting should be to reveal the results of this study so that each teacher of arithmetic will become aware of the proficiency in arithmetic of children of the Missoula grade schools. From the discussion that should come, the teachers would be able to make specific recommendations for their grade as to how to improve the methods of instruction, how to make their teaching more effective and how to make arithmetic as it is taught in the classroom, more practical and more useful.

2. In order to evaluate the arithmetic program as it exists currently, the same test should be given sometime the first week in October so that comparative scores and percentages can be had to determine the effectiveness of the arithmetic instruction. From these results it is likely that other recommendations may be necessary.

3. Teachers in grades six, seven and eight should be provided with a usable handbook which should include the results of past performances of the children in each of the grades for each of the skills. There should also be included in each handbook, methods, techniques and extra aids that will help the teacher improve her effectiveness in the further development of each skill.

4. Each principal should be provided with a similiar diagnostic test which would be administered to each new pupil who enters one of the sixth, seventh or eighth grades in Missoula's Public Schools. This testing would help the teacher find that child's proficiency in the arithmetic

skills and give a method of placing that child in a group needing additional help.

5. A thorough analysis should be made of the achievement test given at the end of each school year. From this analysis should come an evaluation of the achievement of the pupils in grades six, seven and eight. If possible, comparisons between the results of the two tests should be made.

6. Areas where the skills seem most deficient for some children should be noted. Those children who have continued difficulty in accomplishing problems involved in this skill should be given remedial help.

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APPENDIXES

Appendix A

Dear Arithmetic Teacher:

Two years ago we gave a series of basic skill tests known as the <u>Iowa</u> <u>Every</u> <u>Pupil</u> <u>Tests</u> <u>of</u> <u>Basic</u> <u>Skills</u>. Most of us used the results to determine what particular areas were weak and gave additional instruction, however, the tests were not broken down into specific skills, rather, they were divided into larger areas. It would seem that if the full value of the tests were to be utilized, we must break down the areas into the various skills that make up these areas. This I have done. Too, if this study is to be of much value to our system it will be necessary to compute and tabulate the results from all the schools. This I hope to do.

In view of these two needs I am hoping that each of you will take a class period or two to make an itemized analysis of Parts I and II, placing the results on a tally sheet I have provided. Taking this time will certainly be of value to your students because it gives them an opportunity to experience the approach to a scientific method.

You may rest assured that this study is not to compare one grade with another nor will one school be compared with another school. We simply want to find out something more about our arithmetic program, and then if possible, try to improve it. Until I see you personally may I thank you very much for your help.

Edwin Gremmer

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DIRECTIONS to the teacher for tabulating the Iowa Every Pupil Test results:

To eliminate as much error as possible, I have prepared an answer sheet that you may use. Too, I have found that children can do this work if given a little help. I would like to suggest that you use the following directions:

1. Give each child in your room one test answer sheet. (More capable pupils can handle two easily.)

2. You read the answer as it is found on the key sheet naming the square. The answer will be square 1-2-3-4.

3. Have the children raise their hand if the answer on the sheet they are scoring is WRONG. Count the number of WRONG answers, then place this number on the Tally Sheet.

4. Then ask for the children to raise their hands if any child did not try to answer this problem. Count the number of raised hands and place the number in the column of the Tally Sheet marked OMIT.

5. The number RIGHT can be easily determined by subtracting the sum of the WRONGS and OMITS of each problem from the number of pupils tested.

6. Collect the papers and place the answer sheet, Tally Sheet and the instruction sheet in the envelope and give it to the principal.

In order for this method to work, you will have to check all papers in the class at the same time.

ANSWER SHEET

TEST D: BASIC ARITHMETIC SKILLS—FORM O

GRADES 6-7-8

PART I

1.	—	X	—	—
2.	—	—	—	X
3.	X	—	—	—
4.	X	—	—	—
5.	—	—	X	—
6.	—	—	—	X
7.	—	—	X	—
8.	—	X	—	—
9.	—	—	—	X
10.	—	X	—	—
11.	—	—	—	X
12.	—	—	X	—
13.	—	—	X	—
14.	X	—	—	—
15.	—	—	X	—
16.	—	—	X	—
17.	—	—	—	X
18.	—	—	X	—
19.	X	—	—	—
20.	—	X	—	—

21.	—	—	—	X
22.	X	—	—	—
23.	—	—	X	—
24.	X	—	—	—
25.	—	X	—	—
26.	X	—	—	—
27.	X	—	—	—
28.	—	—	X	—
29.	—	—	—	X
30.	—	X	—	—
31.	—	X	—	—
32.	X	—	—	—
33.	—	—	X	—
34.	—	—	—	X
35.	X	—	—	—
36.	X	—	—	—
37.	X	—	—	—
38.	—	X	—	—
39.	—	—	X	—
40.	—	X	—	—

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Section A

Teacher: Children may count the two sample items. Be sure
          they begin with problem 41.

41.	___	___	___	X	57.	___	X	___ ___
42.	___	___	X	___	58.	___	___	X ___
43.	___	___	___	X	59.	___	___	X ___
44.	___	___	___	X	60.	___	X	___ ___
45.	___	___	X	___	61.	X	___	___ ___
46.	___	___	___	X	62.	___	X	___ ___
47.	X	___	___	___	63.	___	X	___ ___
48.	___	X	___	___	64.	___	___	___ X
49.	___	X	___	___	65.	___	___	X ___
50.	X	___	___	___	66.	X	___	___ ___
51.	___	___	X	___	67.	___	___	___ X
52.	___	X	___	___	68.	X	___	___ ___
53.	___	___	___	X	69.	___	___	X ___
54.	X	___	___	___	70.	___	X	___ ___
55.	X	___	___	___	71.	___	___	X ___
56.	___	___	X	___	72.	___	X	___ ___
					73.	X	___	___ ___

Appendix C

FORM I

School_____ Grade_____ Number of Papers_____

PROB.ATPTS.	RIGHT	WRONG	OMITS	PROB.ATPTS.	RIGHT	WRONG	OMITS
1.				37.			
2.				38.			
3.				39.			
4.				40.			
5.				41.			
6.				42.			
7.				43.			
8.				44.			
9.				45.			
10.				46.			
11.				47.			
12.				48.			
13.				49.			
14.				50.			
15.				51.			
16.				52.			
17.				53.			
18.				54.			
19.				55.			
20.				56.			
21.				57.			
22.				58.			
23.				59.			
24.				60.			
25.				61.			
26.				62.			
27.				63.			
28.				64.			
29.				65.			
30.				66.			
31.				67.			
32.				68.			
33.				69.			
34.				70.			
35.				71.			
36.				72.			
				73.			

I wish to thank you teachers and students who have
taken valuable time to help me tabulate all these figures.
Without your help this would have been impossible.

Edwin Gremmer

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Appendix D

<div align="center">

FORM 2

ANALYSIS SHEET PER SKILL AND ITEM

ITEM NO._____   GRADE_____   SKILL NO._____

</div>

School	Number Tested	Attempts	Number Right	Number Wrong	Number of Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted
A								
B								
C								
D								
E								
F								
G								
H								
I								
J								
K								
TOTALS								

Appendix E

FORM 3

COMPUTATION SHEET OF ITEMS AND THEIR RESPECTIVE SKILL

Number_____   Grade_____

Item	Number Tested	Attempts	Number Right	Number Wrong	Number of Omits	Per cent of Attempts Right	Per cent of Attempts Wrong	Per cent of Items Omitted	Per cent of Items Right
TOTALS									

SKILL NUMBER_____

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